

# Finding malfunctions in HVAC installations

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## Abstract

We describe the MonaVisa software tool. This tool automatically analyzes climate control installation performance using data mining techniques. The results of this analysis are presented by means of red & green indicators which indicate whether a component in the system is functioning properly or not. The technology used in this program is based on data mining techniques such as regression and the theories of Mallow.

## Introduction

Energy management of climate control systems is a primary concern for facility managers. Climate control installations have the highest percentage of energy consumption among all building services installations. To optimize the suitable operating parameters without sacrificing thermal comfort, such as chilled water temperature and supply air temperature, will have considerable effects on saving energy.

For typical commercial buildings, however, it is difficult to obtain the correct reference settings for efficient operation; due to the complicated interrelationship of an entire climate control system, which commonly includes water- and aircsystems, it is necessary to suggest optimum settings for various operations in response to the dynamic cooling loads and changing weather conditions throughout the year.

The efficiency of renewable climate control installations is more influenced by malfunctioning of components than conventional installations. Improper use or a lack of proper knowledge of the maintenance crew, incorrect adjustments on the control and installation parameters can cause less efficient installations. Therefore a adequate analyses of malfunctioning is essential.

Analyzing data from a climate control system is a relatively young research area. It is a labor-intensive process that requires a great deal of time and knowledgeable input from employees. With data mining techniques this process can be automated.



Figure 1 Example climate control

## Data collection

An climate control system is almost always linked to a Building Management System (BMS). A BMS is a computer based control system installed in a building that controls and monitors the different components of the climate control system. Another aspect of a BMS system is that the measured data is stored in a database. The structure of the database depends on the manufacturer of the BMS. The MonaVisa software converts the data of these different BMS into a uniform dataset.

## Indicators

MonaVisa gives the user insight how the installation functions. The indicators between red and green give an indication how the components perform on different aspects.

There are four basic aspects in the MonaVisa software [1]:

- comfort
- energy
- process
- component failure

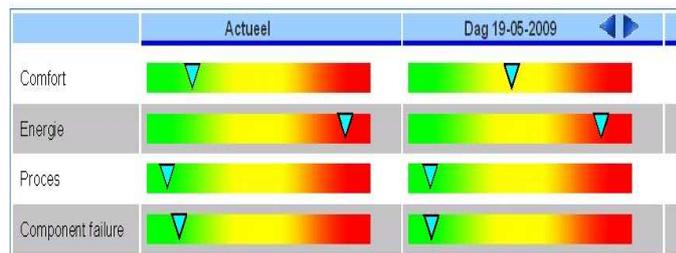


Figure 2 basic indicators

The result of these analyses can be aggregated at component, installation or building level.

## Technology

The technology in the background is based on data mining techniques. With regression techniques a model can be generated for specific components based on data collected from real-time monitoring. These developed models are subsequently used to calculate a predicted value with a certain probability. The difference between the predicted value and the measured value is a indicator for the component performance; if the difference is large, this is an indication that the installation changed behaviour with respect to the original state in which the model was learned. Such model changes could indicate a malfunctioning in the system.

Another technology used is reducing the number of input parameters for the derived models. With robust model selection in regression via weighted likelihood methodology [2] can be considered whether the modelling can take place with a subset of the input variables.

## References

- [1] Factsheet MonaVisa, 2009 [www.monavisa.info/artikelen/FactsheetMonaVisa.pdf](http://www.monavisa.info/artikelen/FactsheetMonaVisa.pdf)
- [2] Claudio Agostinelli, Robust model selection in regression via weighted likelihood methodology, *Statistics & Probability Letters* 56 (2002) 289–300